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REMARKS

In the office action, the examiner rejected Claims 16-18 under 35 U.S.C. 102(b) as being anticipated by Hughes et al. (U.S. Patent No. 5,881,594). The examiner rejected Claims 16, 19-23 and 38 under 35 U.S.C. 103(a) as being unpatentable over Blechner (U.S. Patent No. 3,117,042). Accordingly, the applicant has amended the claims to more clearly differentiate the present invention from the technologies disclosed by the cited references. The applicant has added detailed limitations to Claim 16 and has canceled Claims 17-19. The applicant has introduced a new claim, Claim 40 which corresponds to Claim 20 now canceled and includes detailed limitations added to Claim 16. As a result of the amendment, Claims 16 (independent), 21 and 22 are directed to the invention when the workpiece is made of steel material, and Claims 40 (independent) and 23 are directed to the invention when the workpiece is made of non-steel material.

More specifically, the applicant has added the limitations to Claim 16 so that the features of the present invention reside in that (1) the drilling operation on a machined surface of the workpiece to impart a large local strain to the machined surface, (2) drilling operation causes the machined surface of the workpiece to be subjected to a plastic working with a true strain of at least 1, such that said ultrafine crystal layer is formed on the machined surface, (3) in the drilling operation, when hardness H of the workpiece W is lower than 500 [Hv], a peripheral velocity V of the

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drill D is higher than  $(175 - H / 4)$  [m/min] and a feed amount of the drill per one revolution is smaller than 0.03 mm, and when the hardness H of the workpiece W is higher than 500 [Hv], the peripheral velocity V of the drill D is higher than 50 [m/min] and the feed amount of the drill D per one revolution is smaller than 0.03 mm, and (4) the drilling operation is performed for the workpiece made of steel material with a material temperature at the machined surface being held in a range which is higher than an Acl transformation point of the steel material and lower than a melting point of the steel material.

The features of the present invention defined in Claim 40 are the same with respect to the features (1)-(3) of Claim 16 noted above. Instead of the feature of Claim 16 noted above, the present invention defined in Claim 40 includes the feature (5) the drilling operation is performed on the surface of the workpiece made of a non-steel material with a material temperature at the machined surface being held in a range which is higher than substantially half a melting point of the non-steel material and is lower than the melting point of the non-steel material.

The feature (1) is supported by the original disclosure of the present application, for example, Figs. 1A-1B and 3 and corresponding description in the specification that describe the drilling operation as an embodiment of the machining operation. The feature (2) is supported by the original disclosure of the present application, for example, Figs. 1A-1B and 3 and

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corresponding description in the specification that describes the drilling operation which causes the machined surface of the workpiece to be subjected to a plastic working with a true strain of at least 1, such that said ultrafine crystal layer is formed on the machined surface. The feature (3) is supported by the original disclosure of the present application, for example, Figs. 1A-1B and 3 and corresponding description in the specification such as the paragraph [0070] and [0071] that describe the numerical limitations of the hardness, peripheral velocity, feed amount related to the drilling operation specified in Claim 16. The feature (4) is supported by the original disclosure of the present application, for example, it has been defined in original Claim 19 which is now canceled. The feature (5) of Claim 40 is supported by the original disclosure of the present application, for example, it has been defined in original Claim 20 which is now canceled.

The cited Hughes et al. reference is directed to the method of enhancing the strength of the metals by affecting subsurface zones developed during the application of large sliding loads. Similarly, the cited Blechner reference is directed to the heat-treatment of metals for hardening. As clarified in Claims 16 and 40, the present invention is directed to the drilling operation to improve the hardness, etc., of the machined surface of the workpiece. Rather than the drilling operation, the cited Hughes et al. reference shows the sliding operation, which is mechanically different from the drilling operation. Especially, the present

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invention includes the feature (3) noted above which specifically define the relationship among the hardness of the workpiece and the peripheral velocity and feed amount of the drill. This feature is not shown or suggested by the cited Hughes et al. reference or the cited Blechner reference.

Thus, the present invention is not anticipated or obvious over the cited references taken singly or in combination.


In this opportunity, the applicant has amended the specification to correct the wording errors therein and to more clearly describe the invention. This is to verify that no new matter has been introduced by this amendment.

In view of the foregoing, the applicant believes that the instant application is in condition for allowance, and accordingly, the applicant respectfully requests that the present application be allowed and passed to issue.

Respectfully submitted,

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